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In the Matter of  
U.S. Patent Application No. 10/536,655

## D E C L A R A T I O N

I, Hella Peters, holding a degree conferred upon me by the Ruprecht-Karl University of Heidelberg as a certificate translator of the English language, legally declared a sworn translator by the Regional Court of Hesse in Frankfurt/Main on August 22, 1980, hereby certify that I am well acquainted with both the German and the English languages and that the following is a true translation made by me, Hella Peters, on April 11, 2008, from the German into the English language with respect to German priority patent application 102 55 718.7 of 29 November 2002.

Dated this 11th day of April 2008



Hella Peters  
Sworn Translator

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**Sun-and-Planet Gear**

The invention relates to a novel construction of a sun-and-planet gear (1) which must safeguard a clearance-free comfortable operation and an additional safety of overload protection over its entire useful life.

Preferably, this gear is used in an electromechanical superposition steering system (ESAS) (2) for motor vehicles. Other ranges of application with similar requirements are possible.

In this case, the gear (1) is integrated into the divided steering column (3) of a conventional steering system (4). The intervention of a mounted electric motor (5) will now enable the gear (1) to produce an additional or reduced steering angle (6) at the front wheels (7) (variable steering ratio).

The variable steering ratio as mentioned above renders it possible to configure the steering performance more direct (more agile) or indirect corresponding to the driving situation. It is likewise possible to realize driving-dynamics steering interventions.

Schematic diagram of the superposition steering system (see enclosure 1).

The sun-and-planet gear (1) of the invention satisfies the functionalities demanded for this case of application:

1. Low-noise operation of the sun-and-planet gear during a steering intervention (comfort)
2. Clearance-free operation of the sun-and-planet gear during a steering intervention (comfort)
3. High rate of overload protection safety outside the nominal steering torque range (momentum resulting from misuse)

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4. Customary steering performance with the superposition steering system not active (gear ratio I G (8) of the gear (1) roughly 1:1.

The gear (1) essentially consists of:

- gear input shaft (9)
- sun wheel 1 (10)
- planetary carrier (11)
- planetary wheels (12/13)
- sun wheel 2 (14)
- gear output shaft (15)
- gear casing 1 (16)
- gear casing 2 (17).

Preferably, the sun wheels (10/14) and the gear shafts (9/15) can be of one-part design.

The low-noise operation of the gear as mentioned above is achieved by the division of the sun wheels (12/13) into a plastic part (18) and a metal part (19).

The plastic part (18) and the metal part (19) of the specific planetary wheels (12/13) are equal as regards the number of their teeth, while the plastic part (18), on the other hand, is radially offset from the metal part (19) by a positive profile displacement (20). As a result, only the plastic part (18) comes into contact with the associated sun wheels (10/14). The metal part (19) serves only for the gear of momentum outside the nominal steering torque range, and as an overload protection in the event of momentum resulting from misuse. The plastic part (18) is then deformed in the elastic area, and the corresponding metal part (19) comes into contact with the sun wheels (10/14). Both of the planetary wheels (12/13), as well as the metal part (19), are connected with one another in a form-locking and force-locking manner.

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The operation of the gear (1), which is clearance-free over the entire length of operation, is ensured by a contact force  $F_r$  (21), which is defined radially on the planetary carrier mounting support (20) and the planetary carrier (11). The radial force (21) is preferably produced by means of a spring element (22) integrated into the gear casing (16/17).

The radial force (21) is so defined that, in the nominal steering torque range, the plastic part (18) of the two planetary wheels (12/13) meshes without play with the two sun wheels (10/14). A jerk-free and comfortable operation of the gear (1) is achieved by the radially soft suspension of the planetary wheels (12/13).

When the nominal steering torque is exceeded, the planetary carriers (11), by way of the planetary carrier mounting support (20), will move radially into abutment (23) in the gear casings (16/17) and limit mechanically any additional radial disengagement of the planetary wheels (12/13).

No axial forces arise because of the straight teeth of the gear (1), and these can be kept in their position, rid of play, by means of a contact part (24) integrated into the gear casing (16/17).

A movable bearing (25) integrated into both of the gear shafts (9/15) stabilizes the central axes (26) with one another. Both of the immovable bearings (27) are firmly integrated into the gear casings (16/17) and fix the sun wheels (10/14) axially.

The gearing (toothed belt or spur-toothed gear) (28) of the drive (29) is, preferably, directly integrated with the gear casing (16).

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The geometry of the coupling (30) applied to the gear casing (14) makes possible the application of a locking unit which, in the event of an error, blocks the gear casing (10/14), in a power-free manner, from rotating and prevents a superimposed steering intervention.

A simple axial mounting of the gear (1) is provided by the straight gearing and the divided gear casing.

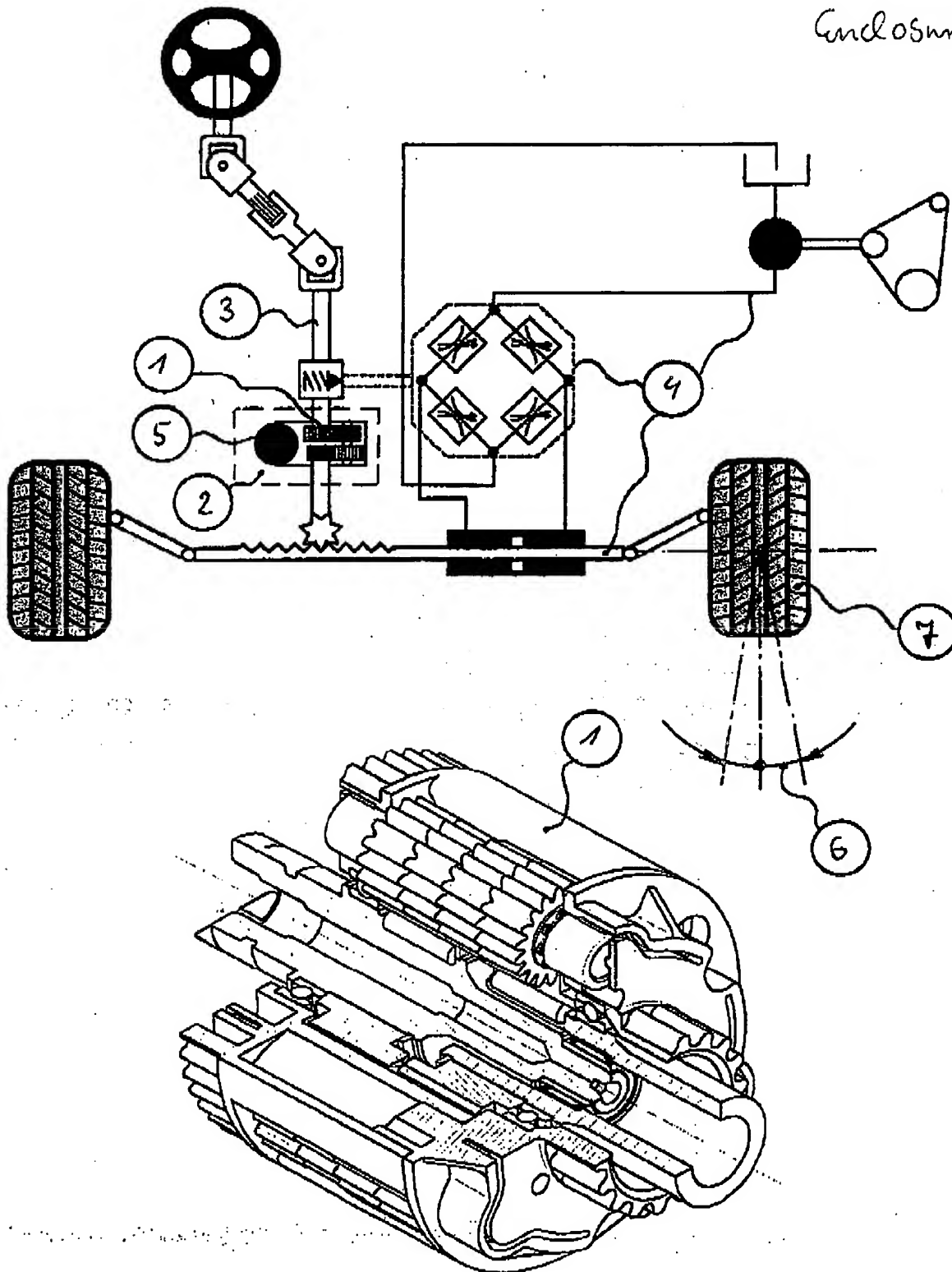
The special advantages of the invention are:

1. Low-noise operation of the sun-and-planet gear during a steering intervention (comfort)
2. Clearance-free operation of the sun-and-planet gear during a steering intervention (comfort)
3. High rate of overload protection safety outside the nominal steering torque range (momentum resulting from misuse)
4. Customary steering performance with the superposition steering system not active

The mentioned advantages are basically achieved by the division of the planetary wheels into a plastic part and a metal part and the corresponding profile displacement. Furthermore, the planets are suspended in a spring assembly in a radially supported fashion.

Anlage 1:

Enclosure 1



Anlage 2:

Enclosure 2

